HIGH TEMPERATURE SEALS TEST RIG

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The High Temperature Seals Test Rig Program at NASA's Lewis Research Center is a joint effort involving three separate federal government agencies. The U.S. Air Force had the rig built under contract by Teledyne CAE in Toledo, Ohio and a series of brush seal tests (Ref. 1) were conducted at Teledyne as part of the contract. At the conclusion of the contract, the USAF chose to locate the rig at NASA Lewis where Lewis could provide support for continued testing. To help provide this support, NASA is receiving assistance from the Vehicle Propulsion Directorate of the U.S. Army Research Laboratory. The U.S. Army provides primary technical support for rig operation while NASA provides primary research and development capability.

Testing has been underway at Lewis in this test rig since April, 1993. The rig was designed to run tests at temperatures to 800 degrees F at pressures to 200 psia or at temperatures to 1300-1500 degrees F at pressures to 65 psia. Because of the difficulties encountered in attempting to maintain high working gas temperatures at the low leakage rates typical of contact seals, the highest temperature and pressure to which seals have been subjected during a test thus far is 700 degrees F and 120 psia. More insulation will be applied to the rig to attempt to raise the maximum operating temperature. In the event that wear data is of primary importance for a particular seal design, the seal can be tested at temperatures greater than 700 degrees F by opening a rig bypass valve. The hot gas bypass valve was incorporated into the design of the rig to allow for shorter rig warm-up times. This action will, however, preclude the measurement of seal leakage.

The rig was designed to run at speeds of up to 50,000 rpm which, for a 5.1 inch diameter disk, is a surface speed of about 1100 ft./sec. However, it was found that at speeds above 35,000 rpm, undue disk vibrations occur that interfere with testing and could lead to shaft failure. To avoid this problem, testing to date has been limited to 30,000 rpm or a surface speed of about 700 ft./sec. A thinner disk is being designed which will weigh approximately half as much as the current disk thereby increasing the critical speed of the rig such that safe testing may be conducted above 30,000 rpm.

The rig was designed to allow easy replacement of the disks as well as the seals such that different disk materials and coatings may be tested using interchangeable disks. Eight disks made of Inconel 718 are currently available; one has no coating, two have a chromium carbide coating, and five have an aluminum oxide coating.

Figure 1 shows a cross section of the rig with the path of hot air flow during a test depicted by arrows. Hot air enters at the top of the rig then flows through a baffle plate before impinging on the disk and seal in an axial direction. The rig bearings are cooled by both oil and an air purge. Air cooling is also provided to reduce the exhaust air temperature. Figure 2 indicates rig instrumentation.

Air Flow Path During Brush Seal Test

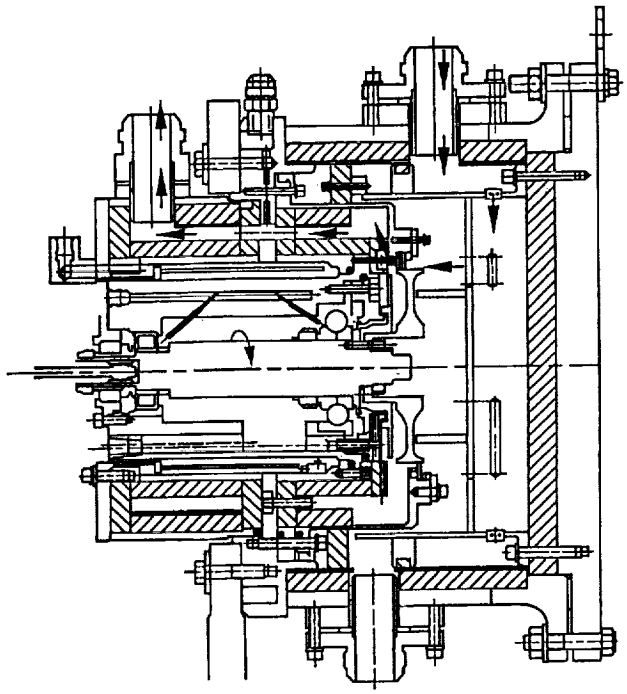

Figure 1. Cross Section of Rig Showing Air Flow

Brush Seal Rig Instrumentation Schematic

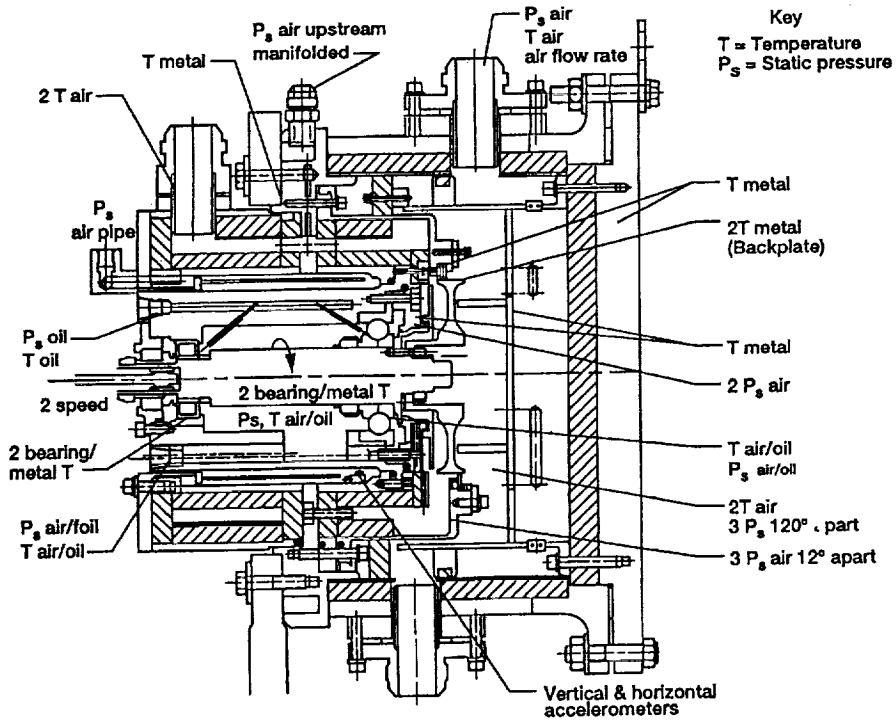

Figure 2. Rig Instrumentation